PATENT APPLICATION

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TITLE OF THE INVENTION

METHOD AND DEVICE FOR DRAFTING AT LEAST ONE SLIVER

FIELD OF THE INVENTION

The invention relates to a method for drafting at least one fiber sliver by means of a auto-leveling spinning preparation machine, particularly a carding machine or draw frame comprising pairs of rollers which are disposed one behind another, whereby the cross-section of the mass of the (at least one) fiber sliver is measured upstream of the roller pairs. The invention furthermore relates a device for the drafting of at least one fiber sliver by means of at least one upstream and one downstream pair of rollers, with at least one sliver cross-section measuring device upstream of these pairs of rollers for the measuring of the cross-section of the mass of the (at least one) fiber sliver.

BACKGROUND

Spinning preparation machines such as cards or draw frames serve the purpose of forming as uniform a textile material as possible from the presented textile material. For this purpose, the machines often comprise a auto-leveling draw frame in order to actuate drafting elements installed one after the other in the direction of sliver movement ~~in~~ as a function of detected fluctuations based on the sliver cross-section fluctuation measured before the draw frame. In draw frames, these drafting elements are constituted e.g. by several pairs of rollers installed one after the other, between which the fiber sliver or slivers is clamped along the

respective so-called nip line in the direction across the sliver. Since the pairs of rollers have different circumferential speeds that increase in the direction of sliver movement, the fiber bundle consisting of one or several fiber slivers is drawn and evened out. In most cases, a second sliver cross-section measuring device is provided at the output of the draw frame to produce an acknowledgment in a closed auto-leveling circuit or to control the evening out and possibly to trigger a machine stop in case of excessive sliver thickness fluctuations.

Mostly mechanical scanning devices have emerged for scanning. For example, the Rieter Draw Frame RSB D30 has a pair of scanning disks with axes that are parallel to each other before the drawing equipment, whereby one scanning disk is fixed in place and the other scanning disk is mobile. The fiber sliver or slivers are guided in a gap between a circumferential groove of the first scanning disk and a circumferential ring of the second scanning disk, whereby the mobile scanning disk is moved away ~~in~~ as a function of the mass fluctuations of the fiber sliver or slivers. The excursion movements are converted by a signal converter into electrical voltage values and are transmitted to an auto-leveling processor to actuate the pairs of rollers of the drawing equipment. Especially in the case of machines where the scanning gear and the pairs of rollers are connected to each other e.g. via a differential gear, the adjustable frequency range is relatively limited with regard to sliver cross-section fluctuations. Because of great mass inertia of such an arrangement, a desired adjustment is not possible over a wide frequency range of long-wave fluctuation (so-called A% values) up to auto-leveling lengths of a few centimeters at high delivery speeds. Furthermore, the wear of machine parts caused

by the great band width of the signal content and the acceleration of large masses connected to it, as well as energy consumption, are relatively high.

Fig. 1 shows auto-leveling drafting equipment in which a fiber sliver FB runs through a mechanical sliver cross-section measuring device 8 and is then guided into drafting equipment constituted by three pairs of drafting rollers 2a, 2b, 3a, 3b, 4a, 4b. The sliver cross-section measuring device 8 is constituted by two scanning disks already described earlier.

One of the two scanning disks is coupled to a clock (pulse) generator 11 producing a given number of cycles or impulses per revolution of this scanning disk. The mobile scanning disk is furthermore connected to a signal converter 10 which converts its excursions into electrical voltage values. These voltage values are transmitted to a measured-value delaying unit 12 which in addition receives a number of cycles from the clock generator 11, representing a measure of the speed of the fiber sliver FB running through the sliver cross-section measuring device 8. In accordance with these cycles of the clock generator 11, the voltage values are held back in the measured-value delaying unit 12 which represents an electronic memory in form of a FIFO (First-in-First-Out) as a function of the distance covered by the fiber sliver between the cross-section measuring device 8 and the drafting equipment. When the fiber sliver reaches the fictitious drafting point in the drafting field of the drafting equipment with the sliver segment to be auto-leveled, the corresponding measured value is released by the measured-value delaying unit 12 and a corresponding adjustment is made as a function of the respective measured value. The distance between the measuring point of the pair of scanning rollers and

the drafting point is called the auto-leveling application point. For this, the measured-value delaying unit 12 transmits the measured values to an algorithm unit 13 which transmits the rotational speed of the drafting equipment rollers concerned and the corresponding information to an auto-leveling drive 22 on the basis of the desired drafting setting and set machine parameters. This auto-leveling drive 22 drives a differential gear 23, which drives the fixed scanning disk of the cross-section measuring device 8, the lower roller 2a of the pair of input rollers, as well as the lower roller 3a of the pair of central rollers. The differential gear 23 receives a basic rotational speed from a main motor 14, and this speed can be adjusted via a rotational-speed adjusting unit 15 configured between the main motor 14 and the differential gear 23.

The main motor 14 in turn drives the lower roller 4a of the pair of output rollers directly, so that a constant sliver running speed is obtained. Accordingly, merely the pair of input rollers and the pair of central rollers are used for auto-leveling.

SUMMARY

It is an object of the present invention to further develop the method and device of the type indicated initially in such manner that a precise drafting of one or several fiber slivers is achieved. Additional objects and advantages of the invention are set forth in part in the following description, or may be apparent from the description, or may be learned through practice of the invention.

The objects are attained through the method indicated initially in that at least one roller of the first pair of rollers is actuated on the basis of the measuring signals

via a first auto-leveling circuit and in that at least one roller of a second pair of rollers is actuated via a second auto-leveling circuit.

The objects are furthermore attained in a device of the type indicated initially by means of two auto-leveling circuits, whereby at least one roller of a first pair of rollers can be actuated via the first auto-leveling circuit and a roller of a second pair of rollers via the second auto-leveling circuit.

The advantages of the invention can be seen especially in the fact that the scanning signals are processed before the drafting equipment in at least two auto-leveling circuits in order to thus increase the flexibility and the precision of the actuation of the drafting elements or rollers. The (at least two) auto-leveling circuits can react in this case to different signal contents and thus take over a distribution of the actuation tasks. In this manner, at least one roller of the first pair of rollers and at least one roller of a second pair of rollers which can be uncoupled at least partially with respect to their mass inertia actuation can be actuated.

It is especially preferred to subdivide the measuring signal portions of the (at least one) cross-section measuring device with respect to its frequency into at least two frequency ranges. Based on the appurtenance of measuring signal portions to different frequency ranges, the rollers of different pairs of rollers can then be actuated. In this manner the auto-leveling is also divided within the frequency range. Thereby every frequency band can be divided among machine elements according to its energy requirements.

The possibility exists of using low-frequency measuring signal portions, i.e. longer-wave sliver cross-section fluctuations, to control machine elements or drive

elements with greater mass moment of inertia. Therefore higher-frequency measuring signal portions can be used to control drive elements with lower mass moment of inertia. Due to the low mass moment of inertia, these machine elements can be accelerated or braked more quickly so that these machine elements can also follow the higher-frequency measuring signal portions. Overall a more precise auto-leveling is achieved thereby, whereby longer-wave as well as shorter-wave fluctuations of sliver cross-sections can be auto-leveled optimally.

It benefits signal processing if the measuring signal portions of the sliver cross-section measuring device upstream of the drafting equipment are assigned to at least one lower and one upper frequency range. In order to be able to use all frequency portions of the sliver cross-section fluctuations, the lower and the upper frequency ranges are preferably close together, and it is especially preferred if they overlap without a gap. The upper frequency range is preferably selected so that an essentially loss-free processing of the machine elements with lower mass moment of inertia is possible. It is also preferable to select the lower frequency range so that an essentially loss-free processing of the machine elements with higher mass moment of inertia is possible.

It has been shown to be advantageous if the lower frequency range comprises frequencies within the range of approximately 0 to 3 Hz, and the upper frequency range comprises frequencies in the range of 3 to 100 Hz. These frequency ranges should however not be regarded as being fixed, but can be advantageously selected or adjusted depending on the auto-leveling draw frame and/or material to be drafted or on other parameters. Nor is the mentioned maximum

frequency of 100 Hz a technologically imposed magnitude. Depending on the design of the drafting equipment or of the participating masses to be accelerated, lower or higher limit values are also possible.

Different possibilities exist for the assignment of different measuring signal portions to different frequency ranges. In preferred examples of embodiments, frequency filters produced in the form of hardware and/or software are used for this purpose.

In the first auto-leveling circuit a roller of the pair of input rollers and one of the pair of central rollers is preferably actuated, while a roller of the pair of delivery rollers is actuated in the second auto-leveling circuit. Contrary to the state of the art described above, the pair of delivery rollers is thus also used for auto-leveling. It is therefore possible to auto-level possible sliver cross-section fluctuations of higher frequency by actuating the pair of delivery rollers due to its lower mass inertia. Since this auto-leveling at output does not produce any additional drafting in the medium, the known disadvantages of output auto-leveling, consisting in particular in variation of the sliver depositing speed and the resulting occurrence of problems in these known machines with regard to clean deposit of the drafted fiber sliver in a spinning can, are avoided. The described preferred variant of the invention provides, however, in principle, an input auto-leveling with superimposed output auto-leveling. The basic drafting and the auto-leveling of low-frequency sliver fluctuation up to e.g. 3 Hz are provided by means of the low-frequency auto-leveling, which is in principle that of the known auto-leveling, e.g. in the Rieter draw frame RSB D30. The upper-frequency band is then modulated up to that drafting by means of the higher-

frequency auto-leveling in the draw frame. This higher-frequency auto-leveling represents a precise CV% auto-leveling, whereby the CV% value is defined as CV% = s/x * 100. Here CV% is the variation coefficient (percentage of sliver unevenness), s is the standard deviation, and x is the mean value of all samples.

The especially preferred embodiment of the invention described above is therefore characterized by superimposed auto-leveling via the output drafting equipment or pair of rollers.

Actuation takes place in the first and second auto-leveling circuit in such manner that the point of auto-leveling application or point of drafting in the drafting field formed by the pair of central rollers and the pair of delivery rollers is identical for both auto-leveling circuits. This means that the point of drafting is identical for both auto-leveling circuits and no delay of measured value of the two auto-leveling circuits relative to each other (by means of a FIFO memory or similar device) is required.

Alternatively or in addition to the actuation of a roller of the pair of delivery rollers, at least one roller of a pair of calendar rollers located downstream of the drafting equipment can be provided in the second auto-leveling circuit, or also in a third auto-leveling circuit. This makes it possible, for example, to coordinate the circumferential speed of the pair of delivery rollers and of the pair of calendar rollers with each other in order to create synchronous running in such manner that no drafting occurs between these two pairs of rollers. It is therefore not absolutely necessary, in using such a design, for the drafted fiber sliver to leave the draw frame at a constant output speed.

Installation of a low-pass filter before a first target value step in the first auto-leveling circuit is especially preferred. The voltage signals released preferably by the measured-value delaying device at first go through this (at least one) low-pass filter before being switched up to a target value step in the first auto-leveling circuit (actual values). This target value step furthermore preferably receives the rotational speed of a main motor (target values) determined by a tachometer generator in order to determine a target value for a first auto-leveling drive from these switched-up signals. The first auto-leveling drive then drives, as in the state of the art, a differential gear which drives the mechanical scanning gear as well as the lower rollers of the input and the central pairs of rollers.

It is especially preferred to install at least one high-pass filter in the second auto-leveling circuit upstream of a second target value step. In addition to the high-frequency voltage signals of the sliver cross-section measuring device (actual values), the voltage signals (target values) representing the rotational speeds of the main motor are preferably also switched up the second target value step. A second auto-leveling drive serving to drive machine elements with lower mass inertia is preferably provided downstream of the output of the second target value step. Such a machine element is preferably a roller of the pair of delivery rollers.

The second auto-leveling drive preferably drives a second differential gear which preferably receives its basic rotational speed also from the main motor. The second auto-leveling drive thus oscillates symmetrically around the rotational speed 0 ~~in~~ as a function of the thick and thin spots of the (at least one) fiber sliver.

Alternatively, the second auto-leveling drive provided in the second auto-leveling circuit for the leveling of the high-frequency measuring signal portions may be designed for direct actuation of at least one roller of the corresponding pair of rollers, preferably the pair of delivery rollers and/or pair of calendar rollers. In this embodiment no differential gear is therefore required in the second auto-leveling circuit. Precise driving of the auto-leveling drive which does not oscillate around the rotational speed 0 is of course required in this case.

In an advantageous alternative embodiment of the invention, the lower frequency range in the first auto-leveling circuit is delimited by a low-pass filter of at least first order, whereby the signals in the upper frequency range are formed from the original measuring signal by subtraction of the low-pass filter signal output. Amplitude and phase errors of the original measuring signals in the upper frequency range or in the second auto-leveling circuit that were locked out by the low-pass filter or were allowed to pass defectively are hereby preferably taken into account.

In an alternative embodiment, the upper frequency range is limited downward by a high-pass filter of at least first order, whereby the signals in the lower frequency range are formed by subtracting the high-pass filter signal output from the original measuring signal. Thereby possible amplitude and phase errors are automatically compensated for, i.e. no amplitude or phase jumps occur.

In an advantageous variant of the invention, machine elements comprising the drafting equipment elements and having an overall higher moment of mass inertia than machine elements with an overall lower moment of mass inertia are used as components to define the low-pass filter. Parts of the machine with relatively

high moment of mass inertia are thereby themselves used as frequency-separating low-pass filter components. The measuring elements run in that case through the first auto-leveling circuit and are furthermore branched off into the second auto-leveling circuit. To control the low-pass filter effect, a tachometer generator can be advantageously provided to measure the rotational speeds of at least one of the drive elements, in particular of a roller, whereby this roller is part of the machine elements with high moment of mass inertia.

In a special embodiment of the variant described above, the output of a first target value step in the first auto-leveling circuit is connected to the input of a target value step in the second auto-leveling circuit. In this embodiment, it is not necessary to split the measuring signal following the measured-value delaying unit by means of a low-pass and a high-pass filter. The measuring signal of the sliver cross-section measuring device can rather be switched up to the target value step in the first auto-leveling circuit following conversion in the signal converter. The output signal of this target value step serves on the one hand to produce a control signal for the drive elements in the first auto-leveling circuit, (the assistance in this by a first auto-leveling drive and a differential gear being especially preferred) and on the other hand in the form of a target value as input signal for a target value step in the second auto-leveling circuit. The actual value for the second target value step is here produced preferably by measuring the frequency portions converted by the machine into amplitude and phase in the first auto-leveling circuit, e.g. by connecting a tachometer generator to one of the central rollers to produce the above-mentioned actual values for the second target value step. The high-pass filter of the second

auto-leveling circuit is thus realized in principle by the machine itself without requiring any other filters, whereby the frequency portions of lower frequencies that the machine can utilize in the first auto-leveling circuit are measured and are subtracted from the measuring signals in the second target value step to be processed overall and comprising all frequencies.

The voltage signals produced by a tachometer generator can be advantageously switched up to the input of the target value step of the second auto-leveling circuit ~~in~~ as a function of the rotational speeds of e.g. a central roller or an input roller. These voltage values of the tachometer generator can be synchronized with a clock generator connected to the sliver cross-section measuring device before they are switched to the input of the target value step of the second auto-leveling circuit.

Instead of merely one sliver cross-section measuring device, it is also possible to use several such measuring devices before the drafting equipment.

The (at least one) sliver cross-section measuring device may be e.g. in form of a mechanical scanning device. Alternatively or in addition, a microwave sensor with a resonator can be used.

Advantageous further developments of the invention are characterized by the characteristics of the sub-claims.

Different examples of embodiments of the invention are explained in further detail below through the figures.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 shows a schematic circuit arrangement according to the state of the art,

Fig. 2 shows a schematic circuit arrangement according to the first embodiment of the invention,

Fig. 3 shows a schematic circuit arrangement according to a second embodiment of the invention,

Fig. 4 shows a schematic circuit arrangement according to a third embodiment of the invention and

Fig. 5 shows a schematic circuit arrangement according to a fourth embodiment of the invention.

DESCRIPTION

Reference is now made to the embodiments of the invention, one or more examples of which are illustrated in the drawings. Each embodiment is provided by way of explanation of the invention, and is not meant as a limitation of the invention. For examples, features illustrated or described as part of one embodiment may be used with another embodiment to yield still a further embodiment.

The different embodiments of the invention to be discussed below are starting from the state of the art shown in Fig. 1. Other drive principles as well as circuit arrangements are however also covered by the inventive idea.

According to Fig. 2 the sliver cross-section fluctuations are determined mechanically by means of a sliver cross-section measuring device 8. The term “sliver cross-section fluctuations” is to be understood within the framework of this

invention also as sliver mass fluctuations, sliver thickness fluctuations, sliver volume fluctuations or similar concepts. The measured values of the sliver cross-section fluctuations are converted in a signal converter 10 into digital voltage signals and are transmitted to a measured-value delaying unit 12 which is realized e.g. in form of a hardware or software FIFO (First-In-First-Out) memory. The sliver cross-section measuring device 8 is furthermore followed by a clock generator 11 producing an impulse ~~in~~ as a function of a given fiber sliver segment length, e.g. 1.5 mm and transmits the impulse number also to the measured-value delaying unit 12. Depending on the running time of the fiber sliver FB from the sliver cross-section measuring device 8 to the desired drafting point or auto-leveling starting point in the drafting equipment consisting of the pairs of drafting rollers 2a, 2b, 3a, 3b, 4a, 4b, the delayed voltage signals are transmitted from the measured-value delaying unit 12 to a low-pass filter 20 in a first auto-leveling circuit. After going through the low-pass filter 20, which may allow the passage of frequencies within a frequency range of e.g. approximately 0 to approximately 3 Hz, the suitably filtered voltage signals are transmitted to a first target-value step 21 in the first auto-leveling circuit. Furthermore, a voltage value is switched up by a tachometer generator 16 which determines the rotational speed of a main motor 14 and converts it into a corresponding voltage signal target values. The output of the target-value step 21 is switched up to a first auto-leveling drive 22 which drives a first differential gear 23. The first differential gear 23 receives the basic rotational speed from the main motor 14 whose rotational speed can be set by a rotational-speed setting unit 15.

The first auto-leveling drive 22 is preferably designed in the form of a servo drive producing a rotational control speed for the differential gear 23 which is preferably in the form of a planetary gear. The differential gear 23, a scanning roller of the sliver cross-section measuring device 8, the lower roller 2a of the pair of input rollers as well as the lower roller 3a of the pair of central rollers are driven at this controlled starting speed of the differential gear 23. The rotational speeds of the rollers 2a and 3a are not necessarily equal. It is possible, for example, to drive them at a fixed rotational speed ratio.

The second auto-leveling circuit according to the invention comprises a high-pass filter 30 at the input of which the voltage values of the measured-value delaying unit 12 are given. The high-pass filter 30 filters the voltage signals and may allow frequencies of e.g. approximately 3 Hz to approximately 100 Hz to pass. The thus filtered voltage signals are switched up to a second target-value step 31 (actual values). The second target-value step 31 receives furthermore the rotational speed of the main motor 14 (target values) converted into voltage values by the tachometer generator 16. The second target-value step 31 determines a control rotational speed from these signals for a second auto-leveling drive, advantageously again a servo drive. The second auto-leveling drive 32 drives a second differential gear 33 of the second auto-leveling circuit, whereby this second differential gear 33 also receives its basic rotational speed from the main motor 14. The lower roller 4a of the pair of delivery rollers is driven at this controlled starting speed of the second differential gear 33. The two auto-leveling circuits thus realize an input leveling with superimposed output leveling, whereby the second auto-leveling drive oscillates

symmetrically around the rotational speed 0. Additional drafting is not produced by the output leveling.

As shown in the embodiment shown in Fig. 2, the longer-wave sliver cross-section fluctuations can be compensated for sufficiently by the machine elements with greater mass inertia such as the mechanical scanning gear of the sliver cross-section measuring device 8, the first differential gear 23, rollers 2a, 3a. The higher-frequency sliver cross-section fluctuation can be compensated for by means of the output leveling by actuating the roller 4a of the pair of delivery rollers. At the starting point of auto-leveling, the frequency ranges are again reunited, so that wear of e.g. motor drive belts, caused by the great sliver width of the signals, can be reduced. The wear caused by the acceleration of great masses as well as increased energy consumption to drive these masses which remains in part without effect in the state of the art because of the impossibility of auto-leveling high-frequency sliver cross-section fluctuations can also be reduced.

In the embodiment of Fig. 2, as well as in the analogous ones of Figs. 3 to 5, the auto-leveling processor comprises the measured-value delaying unit 12, the low-pass filter 20, the high-pass filter 30, the first target-value step 21 and the second target-value step 31. These elements are reproduced in the software in the auto-leveling processor.

The embodiment of Fig. 3 differentiates itself from that of Fig. 2 in that it does not have its own high-pass filter to filter the voltages representing the low-frequency sliver cross-section fluctuations. The unfiltered voltage signals on the one hand and the voltage signals filtered by a low-pass filter 20 as in Fig. 2 are switched on the

other hand to a subtraction element 135 by the measured-value delaying unit 12. The subtraction element 135 delivers the output values which only contain the high-frequency signal portions of the sliver thickness fluctuations and transmits these in the form of target values to a second, multiplying target-value step 131 of the second auto-leveling circuit. The target values of this second multiplying target-value step 131 are received by a tachometer generator 16 converting the rotational speed of the main motor 14 into a corresponding voltage signal, similarly as in the embodiment according to Fig. 2. The functionality of the embodiment according to Fig. 3 is otherwise analogous to the one of Fig. 2.

Fig. 4 shows a third embodiment of the invention. The first auto-leveling circuit, with a first target value step 221, a first auto-leveling drive 22 and a first differential gear 23 are unchanged from the embodiment as in Fig. 2 (merely the low-pass filter 20 is missing). An output leveling superimposed according to the invention is realized in this embodiment in that the output of the first target value step 221 is not only applied to the first auto-leveling drive 22 but also as a target value to the second, subtracted target value step 231 of a second auto-leveling circuit. The actual values for this second target value step 231 are determined from the voltage values produced by a tachometer generator 17 which detects the rotational speed of the upper roller 3b of the central pair of rollers in the embodiment shown. The rotational speed of one of the rollers 2a, 2b, 3a for example could also be scanned.

In other words, a high-pass filter is realized in the second auto-leveling circuit by the machine itself, whereby the tachometer generator 17 measures the frequency

portions converted by the machine in the first auto-leveling circuit into amplitude and phase, i.e. measuring signal portions of relatively low frequency in order to subtract them from the overall signal which contains all the frequency portions in the second target value step 231.

As a result of the comparison between the subtraction of the target and actual values, the second target value step 231 determines target values corresponding to the high-frequency measuring signal portions for a second auto-leveling drive 32 which produces a control speed for a second differential gear 33 from this target value. The lower roller 4a of the pair of delivery rollers is driven with this controlled starting speed of the second differential gear 33. As a result the desired drafting changes are obtained in the main drafting field formed by the pair of central rollers and the pair of delivery rollers, so that the sliver cross-section fluctuations of the entering sliver or slivers FB can be leveled.

In the embodiment of Fig. 5, similarly to that of Fig. 2, a low-pass filter 20 and a high-pass filter 30 are again provided to divide the measured-signal portions of the sliver cross-section measuring device 8 into low-frequency signal portions and high-frequency signal portions. Of course several filters can be provided for the respective frequency ranges, as also in the similar embodiments described before. The essential difference in the embodiment of Fig. 5 from that of Fig. 2 is that the control speed produced by the second auto-leveling drive 32 is not given to a differential gear but is switched directly to the lower roller 4a of the pair of delivery rollers. It should be noted that of course in this as in preceding embodiments, it is also possible to drive the upper rollers of the different pairs of rollers. By actuating

the roller 4a directly, the second differential gear can be omitted. In this embodiment a coupling of input leveling to output leveling must however be omitted. The output leveling can rather produce additional drafting by means of the second auto-leveling drive so that the delivery speed is not necessarily constant. In that case the possibility is given that the second auto-leveling drive 32 may drive in addition pair of calendar rollers or a draw-off device downstream of the drafting equipment so that the pair of delivery rollers and the pair of calendar rollers may convey the fiber sliver synchronously.

The invention can also be used with individual drives in spinning machines. It is essential that sliver cross-section fluctuations from signals received before the drafting equipment is leveled in at least two auto-leveling circuits so as to be able to take into account in particular the different moments of inertia of different machine elements in these auto-leveling circuits. Thereby a frequency band width enlargement can be obtained in leveling drafting of the (at least one) fiber sliver.

It should be appreciated by those skilled in the art that modifications and variations can be made to the embodiments described herein without departing from the scope and spirit of the invention as set forth in the amended claims and their equivalents.